depression (LTD), and there is strong experimental evidence that these changes are driven by the postsynaptic Ca2+ concentration. Previously we examined a computational model of STDP that combines the chemical network model of Pi and Lisman (2008), with a model of Ca2+ dynamics that builds on the work of Shouval and coworkers (2002) to explain experimental studies of STDP in response to pre- and post-synaptic spike pair protocols (Carlson and Giordano, 2010). Wang et al. (2005) have also explored more complex spike timing protocols such as triplets and quadruplets, and the results in some cases cannot be explained simply in terms of the STDP behavior found in response to spike pairs. For example, a spike pair triplet can be viewed as a combination of one spike pair (spikes 1 and 2) followed by a second spike pair (spikes 2 and 3), and in some cases the resulting STDP is not the simple sum of that found for the two spike pairs. We have extended our model of STDP to explore the multi-spike cases studied by Wang et al. and careful examination of the Ca2+ dynamics shows how such ''non-additivity'' can occur.

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522-Pos Board B322

Diffusion from Point-Source in Oriented Fiber Ensembles with Different Volume Fractions

Charles Nicholson.

A major source of diffusion anisotropy in the central nervous system is the presence of oriented fibers (e. g. corpus callosum; cerbellar molecular layer). The diffusion properties may be explored experimentally using a point-source paradigm based on tetramethylammonium (TMA; Sykova & Nicholson, Physiol. Rev. 2008, 88, 1277). To better understand such results the MCell Monte Carlo program (www.mcell.psc.edu) was used to model diffusion from a point source in bundles of rectangular fibers with extracellular volume fractions (α) ranging from 0.02 - 0.8.

The simulation employed 64 rectangular rods each of 0.6 x 0.6 μm in cross-section with surfaces that reflected the particles. Rods were spaced appropriately to obtain the required α and the length of each rod was chosen to make the rods into a cubic ensemble. A population of 250,000 point particles was released into the center of the ensemble with free diffusion coefficient (D) equal to that for TMA and the simulations run with a time-step of 10 ns for 1 ms. These parameters ensured that the particles remained within the ensemble.

It was found that the component of the effective diffusion tensor, D^*, aligned with the direction of the bundles was equal to D so the tortuosity ($\lambda = (D/D^*)^{1/2}$) was unity in this axis. For the two symmetrical components of D^* in the orthogonal axes, λ was a function of α that could be accurately describe by an expression derived by Bell & Crank (J. Chem. Soc. Faraday Trans., 2, 1974, 70, 1259). These results are compared to those already obtained for an assembly of cubes (Tao & Nicholson, J. Theoret. Biol. 2004, 229, 59). Supported by NIH/NINDS Grant R01-NS-28642.

523-Pos Board B323

Calcium Imaging in Drosophila During Walking and Flight Behavior

Johannes D. Seelig, M Eugenia Chiappe, Gus K. Lott, Michael B. Reiser, Vivek Jayaraman.

Drosophila melanogaster is a genetic model organism with many experimental advantages, including the ability to genetically manipulate specific sub-populations of neurons. The combination of physiology and genetic tools is increasingly being applied to questions in systems neuroscience [1].

Our goal is to understand circuit computations underlying sensory-motor transformation in the fly brain. This requires recording not just neural activity but also the fly's behavior. Towards this end, we have developed a novel experimental setup [2] for two-photon calcium imaging while the fly is walking on an air-supported 'Buchner' ball [3, 4] in a virtual arena [5]. These recordings represent the first examples of functional imaging in behaving Drosophila and provide a platform for future explorations of decision-making and sensory-motor transformations in this powerful genetic model organism. We have also adapted the setup for calcium imaging in tethered flying Drosophila. In complementary work, a different group has succeeded in whole-cell patch-clamp recording from fruit flies during flight behavior [6].

Motion-sensitive interneurons in the visual system of walking and flying Drosophila show modulation of their responses depending on their behavioral state [6, 7]. Under natural conditions the visual input of the fly changes and is controlled by the movement of the fly. Closed-loop tethered behavior allows approaching this situation in a controlled experimental setting. We demonstrated the feasibility of closed loop flight behavior during calcium imaging and compare neuronal responses during open and closed-loop flight behavior.

1. Olsen and Wilson (Trends Neurosci., 2008)
2. Seelig, Chiappe, Lott, Dutta, Osborne, Reiser, Jayaraman (Nat Meth, 2010)
3. Gotz and Wenking (J Comp Physiol, 1973)
4. Bohm, Schildberger and Huber (JEB, 1991)
5. Reiser and Dickinson (J Neurosci Meth, 2008)
6. Maimon, Straw, Dickinson (Nat Neurosci, 2010)
7. Chiappe, Seelig, Reiser, Jayaraman, (Curr Biol, 2010)

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Mitochondrial Trafficking on Axons as a Function of Substrate Stiffness

Carlos Luna, James M. Love, Sameer Shah, Helim Aranda-Espinoza.

Mitochondria are the energy machinery necessary for the maintenance of axonal growth, calcium management and other neuronal functions and disruption of their transport results in neurological disease. Due to the length of neurite extensions, mitochondria travel along microtubules and actin filaments to reach different places along the axon; thus, their transport and density is regulated by the activity of axonal zones and growth cones. Mitochondrial trafficking has been linked to axonal growth and thus is an important property in the study of neuroregeneration. It has previously been shown that axonal growth depends on substrate stiffness, suggesting that the mechanical properties of the substrate might play an important role in axonal transport. In this work we analyzed the transport of mitochondria along the axon as well as the distribution in the growth cone as a function of substrate stiffness, by imaging axonal transport of mitochondria in vitro on cultured rodent DRGs. These results provide insight into the transport mechanisms along the axon as a function of substrate stiffness. Furthermore, these results deepen our knowledge of the effects of mechanical properties of the substrate on the activity of axons and growth cones and show that mitochondrial trafficking may play a role in these effects.

525-Pos Board B325

Coming to an Understanding of Fixational Eye Movements

Sarai Manzano.

Fixational eye movements play a major role in visual perception; without such movements the world would quickly fade away. We are using a mathematical description of fixational eye movements combined with a realistic biophysical model of the primate retina to obtain a better understanding of how fixational movements contribute to visual perception. Physiologically realistic jitter was used to modulate the retinal location of an otherwise stationary image, here consisting of Gaussian-weighted sinusoidal gratings with superimposed 1/f background noise. Images were reconstructed using either 1) the mean or 2) the cross-covariance of the simulated retina output. To assess the quality of the two reconstruction methods, reconstructed images were classified as either vertical or horizontal. Our preliminary findings suggests that the spatial correlations produced by fixational eye-movements can contribute to visual perception. Ultimately, the predictions of the model can be tested in psychophysical studies.

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Wave Propagation in Excitable Random Networks with Spatially Constrained Connections

Nikita Vladimirov, Roger D. Traub, Yuhai Tu.

We study wave propagation in excitable Greenberg-Hastings cellular automaton on random (Erdos-Renyi) graph, where connections are spatially constrained within radius r_c. We show that governing equation resolved by parabolic Fisher-Kolmogorov equation fails to describe wave speed, but a hyperbolic reaction-diffusion equation provides adequate wave speed for arbitrary mean network degree k. In more general case, wave speed depends rather on ratio of network moments (second moment/first moment). The wave speed is strikingly similar in different network topologies, including constant-degree, exponential and power-law degree distributions. Inspired by problem of firing propagation in networks of electrically coupled pyramidal neurons, our results may suggest spatial mean-field solution for a wide class of similar problems, such as spread of epidemics or information through real-world networks of arbitrary topology.